

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 21.—“A possible Explanation of the two fold Spectra of Oxygen and Nitrogen.” By E. C. C. Baly.

The two spectra of oxygen are shown to be of a different nature. They behave differently, and reasons are given for their being in all probability the spectra of different gases. They may either be two spectra produced by different vibrations of the oxygen molecule, or they may be the spectra of two different modifications of oxygen, or the spectra of two distinct gases resulting from a dissociation of oxygen, a combination of which is called oxygen.

It appeared worth while to undertake experiments with a view of testing the last of these. Oxygen was sparked in an apparatus similar to that used by Prof. J. J. Thomson in his experiments on the electrolysis of steam. Hollow platinum electrodes were used, each one of which was connected with a Sprengel mercury pump. In the first experiments, the distance between the electrodes was 35 mm., and the highest pressure compatible with the appearance of the two spectra was made the starting point of the experiments. In these first experiments it was 380 mm. The density of the oxygen before sparking was determined, and taken as a test of its purity. The fractions obtained from the anode and cathode were weighed, and the results are given. They follow the lines of J. J. Thomson's results, inasmuch as with long sparks a lighter fraction was obtained at the cathode, and with short sparks a heavier fraction. The fractions from the anode were not so definite as from the cathode, though the difference was in the right direction. The probable maximum error of weighing was 0.0001 gram. This meant exactly one in the second decimal place of the density obtained. The general accuracy of the results may be gauged from the densities of unsparked oxygen obtained.

Density of cathode fraction with long sparks.		Density of oxygen unsparked.		Density of cathode fraction with short sparks.
15.78	...	15.88	...	16.00
15.79	...	15.87	...	16.01
15.80	...	15.89	...	16.02
15.79	...	15.88	...	16.04
		15.88	...	16.06
				16.05

Mean of results of other observers = 15.887.

Density of cathode fraction from oxygen, previously for three days fractionated with short sparks, 15.75.

The experiments are still in progress.

Physical Society, March 22.—Mr. R. T. Glazebrook, F.R.S., in the chair.—On the objective reality of combination tones, by Prof. A. W. Rücker and Mr. E. Edser. The question as to the objective or subjective nature of combination tones has excited much keen controversy, and the authors have devised some experiments to elucidate this point. These experiments, some of which were exhibited before the Society, show that under certain conditions difference and summation tones are produced which are capable of disturbing resonating bodies. As resonator they have, in the first instance, employed a tuning-fork. A piece of thin wood, about 5 in. square, is attached to one of the prongs of this fork, while a silvered glass mirror is attached to the other, and the pitch of the fork is very accurately adjusted to sixty-four complete vibrations per second. In order to detect any movement due to resonance set up in this fork, the mirror carried by the prong forms part of a system of mirrors for producing Michelson's interference bands. By this means a movement of the prongs of the fork of $1/80,000$ of an inch (half a wave-length of light) is shown by the disappearance of the interference bands. As a source of sound a siren was employed, this being one of the instruments which Helmholtz recommends as giving the best results. The pitch of the notes given by the siren was adjusted by noting the disappearance of the beats produced by one of the notes with a bowed fork, or by a stroboscopic method. A large wooden cone, placed between the siren and the resonating fork, served to concentrate the sound on the wooden disc attached to this latter. The sensitiveness of the arrangement is such, that when a large Koenig standard fork, giving sixty-four vibrations per second, is struck so lightly that an observer, with his ear close to the fork, cannot detect the fundamental note, the bands instantly disappear.

The apparatus, however, is unaffected by any other note, except one of sixty-four vibrations per second. A number of experiments have been made, using various rows of holes on the siren, and in every case when the summation or difference tone corresponded to sixty-four vibrations per second, the interference bands vanished, showing that under the conditions of the experiment these tones have an objective existence. An experiment has also been made to determine whether Koenig's lower beat tone when the interval is greater than an octave is objective. In this case, however, the authors entirely failed to get any evidence of such an objective existence. A number of experiments have been made with a view to elucidating the cause of the production of the summation tone, which tend to show that it is not the difference tone of the partials of the fundamental notes. In addition to using a tuning-fork to detect the combination tones, the authors have made use of an instrument originally devised by Lord Rayleigh. A light mirror is suspended by means of a fine quartz fibre, and hangs in the neck of a resonator, tuned to the given note, and when at rest is inclined at 45° to the axis of the resonator. Under these circumstances, when the resonator responds the mirror tends to turn and set itself at right angles to the direction of motion of the air in the resonator. The results obtained with this instrument are in complete accord with those obtained by the first method. Up to the present the authors have failed to obtain any evidence of the objective reality of the combination tones produced by organ-pipes and tuning-forks (see p. 474). The discussion on this paper was postponed till after the reading of the next paper.—Some acoustical experiments, by Dr. C. V. Burton. (1) On the subjective lowering of pitch of a note. The author has noticed that if a tuning-fork, mounted on a resonator, is strongly bowed, then if the ear is placed near the opening of the resonator the pitch of the note heard appears lower than when the fork is bowed very gently or is held at some distance. This subjective lowering of pitch is most marked with forks of low pitch; and in the case of a fork giving a note of 128 complete vibrations per second, amounts to about a minor third. The author suggests an explanation depending on the supposition that the basilar membrane of the ear behaves as if it consisted of a number of stretched strings of various lengths, each resounding to a given note; and that the appreciation of the pitch of a note depends on the localisation of the part of the basilar membrane which resounds most strongly. Further, he shows that in the case of a stretched string, for finite displacements, the string which most strongly resounds to any note will have a “natural” period longer than the period of the disturbance; the greater the disturbance the longer will be the natural period of the strings most strongly affected. Hence when the intensity of a note increases, the tract of the basilar membrane most strongly affected is displaced in the direction which corresponds to the perception of lower notes. (2) Objective demonstration of combination tones. Where two organ-pipes are sounded and alternately separated and brought close together, an observer, at some distance, hears the difference tone much more clearly when the pipes are close together than he does when they are separate. As the position of the pipes with reference to his ear does not appreciably change, the change in the intensity of the combination tone indicates that it has a real objective existence. The author mentioned that he had sounded his two pipes, which give a difference tone of 64 vibrations per second, before the collector of Prof. Rücker and Mr. Edser's apparatus, but without obtaining any motion of the interference bands, and that he was therefore less confident of the correctness of his deductions than he had been before. Mr. Edser mentioned that Dr. Burton had suggested an explanation of the production of objective tones in the case of the siren, which depends on the production of the tones in the wind-chest of the instrument itself when two rows of holes are simultaneously opened. They had made an experiment which seemed to show that the above explanation was incorrect, for on connecting together the wind-chests of two sirens, fixed on the same spindle, by means of a short length of wide metal tubing, no effect was observed on the bands when the two notes were produced on different instruments having what was practically a common wind-chest.—Prof. Everett (communicated) said he considered the experiments described in the paper proved conclusively the objective existence of the summation tones as distinguished from supposed beat tones. He had lately been investigating the pitch of the loudest combination tone obtained when two notes having frequencies as 3 to 5 are sounded. Is

the frequency of this tone 2, *i.e.* the first difference tone, or is it 1, which corresponds to the first term of the Fourier series for the periodic disturbance? In the chords 2 to 3, 3 to 4, 4 to 5, &c., the difference of the integers being unity, the first difference tone is identical with the first Fourier tone. When the difference of the two integers which express the chord is not unity, then the writer considers that experiments he has made with strings and pipes, show that the first Fourier term is usually the only combination tone that is audible. Prof. S. P. Thompson considered that care should be taken to define what we mean by the subjective or objective existence of a note. There are two very delicate methods which have already been employed for detecting the existence of a given note in the air. (1) The formation of ripples on a soap-film stretched over the opening of a resonator tuned to the required pitch (Sedley Taylor); (2) the sounds produced in a telephone connected to a microphone placed on a thin elastic membrane stretched over the neck of the resonator (Lummer). It was very important to limit our acceptance of the demonstration of the objectivity of combination tones, given by the authors of the paper, to the case actually proved, *i.e.* to tones produced by the polyphonic siren. It did not necessarily follow that if pure tones produced by tuning-forks were used, the same results would be obtained. A number of experiments had been made by Zantedeschi in 1857, in which two notes were sounded, and skilled musicians were asked to record their impression of the third tone present. In 75 per cent. of the cases the note recorded was the difference tone; in the remaining 25 per cent. it corresponded to Koenig's beat tone. Koenig himself had never heard the summation tone in the case of lightly-bowed forks. Voigt in a theoretical paper has shown that if there are two disturbances whose mean kinetic energy differ, the Helmholtz tones will be produced; but that if the mean kinetic energy of the two disturbances are equal, the Helmholtz effects soon die out, and you get beat tones or beats. He (Prof. Thompson) considered that Dr. Burton had allowed his perception of tone to be governed by the quality of the note, and that the apparent lowering of pitch was due to the variation in the intensity of the overtones present. In reply to Prof. Thompson, Dr. Burton said he did not merely perceive a lowering of pitch, but he was able to estimate the change in pitch, and say at what instant, as the vibrations of the fork died out, the lowering amounted to a tone or half a tone, &c. Mr. Boys said he found that by careful attention he could apparently persuade himself that the note in Dr. Burton's experiment was lowered or raised in pitch, or that it remained unaltered. A similar effect in the case of the eye could be obtained with a stereoscopic picture. The Chairman considered that, while Helmholtz' explanation of the production of combination tones might be real, it did not follow that this explanation gave the sole cause of their formation. In particular, Helmholtz does not explain why the tones should only be produced by some sources of sound. Prof. Rücker, in his reply, said he did not deny the existence of Koenig's beat tones; in fact, he had heard them. They did not lay much stress on the negative result of the experiment they had made to test the objective existence of these beat tones.

Zoological Society, March 19.—Sir W. H. Flower, K.C.B., F.R.S., President, in the chair.—Lt.-Col. H. H. Godwin-Austen, F.R.S., presented a paper on behalf of Mr. Walter E. Collinge, and himself, "On the Structure and Affinities of some new Species of Molluscs from Borneo." Three new species were described, viz. *Damayantia smithi*, *Microparmarion pollonerai*, and *M. simrothi*. Details were given of their structure and comparisons instituted with other members of the genera and allied Indian genera. One of the most interesting features, perhaps, was the similarity they show anatomically to shell-bearing molluscs of Borneo. That these slug-like forms of Borneo have the same close relationship to the shell-bearing mollusca among whom they are now found living, as the Indian forms bear to *Macrochlamys* and allied shell-bearing genera, there can be little doubt, and any true attempt at classification must be based on these lines, and would place a wide gulf between *Girasia* and *Austenia* on the one side, and *Parmarion* and *Microparmarion* on the other.—Mr. F. E. Beddard, F.R.S., read a preliminary account of new species of earthworms belonging to the Hamburg Museum. These worms belong chiefly to the genera *Acanthodrilus* and *Microscotlex*, and had been collected in South America.—Prof. F. Jeffrey Bell communicated, on behalf of Prof. Alphonse Milne-

Edwards, Jardin des Plantes, Paris, the description of a new species of crab of the genus *Hyastenus*, obtained near the Straits of Magellan during the *Challenger* Expedition, and proposed to be described as *H. consobrinus*.—Dr. A. G. Butler gave an account of two collections of Lepidoptera received by the British Museum. One from Zomba, made by Mr. J. McClounie, remarkable for the number of specimens of the fine Butterfly genus *Charaxes* it contained. The other made at Fwambo, Lake Tanganyika, by Mr. Alexander Carson, interesting as including not only rare species previously only received from Zomba and Lake Mweru, but several novelties, the finest of which was *Junonia pavonina*, a new form allied to *J. artaxia*.—Mr. P. Chalmers Mitchell read a paper in which he gave a description of the proventricular crypts he had found in a specimen of the African Tantalus (*Pseudotantalus ibis*) recently living in the Society's Gardens.

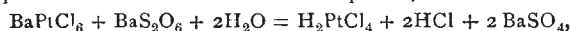
Entomological Society, March 20.—Prof. Raphael Meldola, F.R.S., President, in the chair.—Mr. H. St. John Donisthorpe exhibited a living female of *Dytiscus marginalis*, with elytra resembling those of the male insect. Dr. Sharp, F.R.S., said he had seen this form before, but that it was very rare in this country, though abundant in some other parts of the palæarctic region. Prof. Stewart asked if the genitalia had been examined. Mr. Champion stated that Mr. J. J. Walker had collected several females of an allied species (*Dytiscus circumflexus*) at Gibraltar with elytra resembling those of the male.—Dr. Sharp exhibited specimens of *Brenthius anchorago*, from Mexico, showing extreme variation in size. He remarked that the males varied from 10½ mill. in length to 51 mill.; the female from 9½ mill. to 27 mill. In the male the width varied from 1½ mill. to 4 mill. The length therefore varied from about 5 to 1, and the width from 3 to 1 in the male.—Mr. Blandford commented on the difficulty of mounting minute Lepidoptera, Diptera, Neuroptera, &c., and exhibited samples of strips of material which he had found most suitable for the purpose of staging minute insects. He said his attention had been called to this method of mounting by the receipt of specimens from Dr. Frič, of Prague. On examination of the material he found it to be a fungus, *Polyporus betulinus*. He stated that Lord Walsingham had expressed his satisfaction with this material, and had sent him specimens, similarly mounted, from Zeller's collection. Mr. McLachlan, F.R.S., remarked that he thought the material exhibited preferable to artichoke pith, which had been used for a similar purpose.—Mr. Goss exhibited a species of a Mantid, *Pseudocreobotra Wahlbergi*, Stål, received from Captain Montgomery, J.P., of Mid-Ilovu, Natal.—Mr. Frederick A. A. Skuse communicated a paper, entitled "On a colour variety of *Heteronympha merope*, Fab., from New South Wales," and sent coloured drawings of the typical form and the variety for exhibition.—Mr. Oswald H. Latter read a paper, entitled "Further notes on the secretion of potassium hydroxide by *Diceranura vinula* (imago) and similar phenomena in other Lepidoptera." The paper was illustrated by the oxy-hydrogen lantern. Prof. Meldola congratulated Mr. Latter on the thorough way in which he had worked out his experiments, and said that in view of the small quantity of material at his disposal, the concordance in the results was remarkable. He added that Mr. Latter had, for the first time, proved the secretion of free potassium hydroxide in the animal kingdom. Mr. Blandford, Mr. Merrifield, and Dr. Dixey continued the discussion.—Mr. Merrifield read a paper, entitled "The results of experiments made last season on *Vanessa C-album* and *Limenitis sibylla*." This was illustrated by an exhibition of specimens of *L. sibylla*, and a long series of *V. C-album*, to show the effects of temperature in producing abnormal forms. Dr. Dixey said that many of the forms of *V. C-album* exhibited reminded him of *V. C-aureum*, a Chinese species, which he believed to be one of the oldest forms of the genus. He thought that much of the variation shown in this series of specimens was due to atavism, and was not directly attributable to the effect of temperature. Mr. Barrett said he was interested to find that one of the forced forms of *L. sibylla* was similar to a specimen he had seen which had emerged from the pupa during a thunderstorm. In connection with Mr. Merrifield's paper, Mr. F. W. Frohawk exhibited a series of 200 specimens of *V. C-album*, bred from one female taken in Herefordshire, in April 1894. The series consisted of 105 males and 95 females, and included 41 specimens of the light form, and 159 of the dark form. Prof. Meldola, in proposing a vote of thanks to Mr. Merrifield, Dr. Dixey, and Mr. Frohawk, said that he was glad to think

that the subject of seasonal dimorphism, which had been first investigated systematically by Weismann, was receiving so much attention in this country. He was of opinion that the results hitherto arrived at were quite in harmony with Weismann's theory of reversion to the glacial form, and all the evidence recently accumulated by the excellent observations of Mr. Merrifield and others went to confirm this view as opposed to that of the direct action of temperature as a modifying influence.

Mathematical Society, March 14.—Major P. A. MacMahon, R.A., F.R.S., President, in the chair.—The President announced that he had written letters of condolence to Lady Cockle and Mrs. Cayley, and had received their acknowledgments of receipt of the same, which he communicated to the meeting.—Prof. Hill, F.R.S., communicated a paper, by Mr. F. H. Jackson, entitled "Certain Π Functions," and the President (Mr. A. B. Kempe, F.R.S., in the chair) read a paper on the perpetuant invariants of binary quantics.—Lieut.-Col. Allan Cunningham, R.E., gave a proof that $2^{197} - 1$ is divisible by 7487.—The President read a letter from the Rev. T. C. Simmons, announcing what the writer believed to be a "new theorem in Probability."

PARIS.

Academy of Sciences, March 25.—M. Marey in the chair.—On the theory of surfaces and of algebraical groups, by M. Émile Picard.—New researches by Prof. Ramsay on argon and on Helium, communicated by M. Berthelot. A letter from Prof. Ramsay was read describing the spectrum of argon obtained from clèveite and the discovery of Helium.—Remarks on the spectra of argon and of the aurora borealis, by M. Berthelot. During the author's recent experiments on the condensation of argon with benzene vapour under the influence of the silent discharge, a magnificent greenish-yellow fluorescence was observed. Its spectrum consisted of a series of lines and remarkable bands. So far as the experimental conditions allowed of comparison, this spectrum recalled that of the aurora borealis. It is suggested that this phenomenon may possibly be due to the formation of some fluorescent combination of argon in the upper regions of the atmosphere under electrical influence.—Researches on the metals of Cerite, by M. P. Schützenberger. The preparation of cerium sulphate in a state of such purity as to admit of accurate determinations of the atomic weight of cerium is described. The value 139.45 is obtained for this constant by a special process of estimating the sulphuric acid in this sulphate. It is shown that other methods of obtaining the atomic weight give unreliable results. Taking various fractions of the sulphate on recrystallisation, the later fractions give a much less value for the atomic weight of cerium than the earlier ones.—Observations of Charlois' planet BU, made at Toulouse observatory, by MM. B. Bailly and Rossard.—Observations of Wolf's planet BT (March 16, 1895), made at Besançon observatory, by M. H. Peit.—A general property of axoids, by M. A. Mannheim.—On lines of curvature, by M. Thomas Craig.—On the theory of equations to the derived partials, by M. Wladimir de Tannenber.—On linear equations to the derived partials, by M. Émile Borel.—On the movement of projectiles in the air, by M. Chapel. A series of four equations are given which supply a complete solution to the ballistic problem for speeds ranging between 300 m. and 1100 m.—On the extension to magnesia of a method of synthesising fluorides and silicates, by M. A. Duhoi. The compounds MgF_2 , KF , $MgF_2 \cdot 2KF$, and $MgO \cdot K_2O \cdot 3SiO_2$ are described and their optical and chemical properties given.—On a new method for the preparation of chloroplatinous acid and its salts, by M. Léon Pigeon. Reduction of chloroplatinic acid in accordance with the equation,



is employed. Following the method given in detail, the yield is almost theoretical.—Heat of formation of calcium acetylide, by M. de Forcrand. The heat of formation of solid C_2Ca from diamond and solid Ca is -7.25 Cal., substituting amorphous carbon it is -0.65 Cal., for gaseous carbon it is $+76.95$ Cal.—Action of ortho-amidobenzic acid on benzoquinone, by MM. J. Ville and Ch. Astruc.—Alterations in saccharine matters during the germination of barley, by M. P. Petit. The conclusions are drawn: (1) There is a relation between the quantities of reducing sugars and of saccharose existing in barley during its germination. (2) The formation of saccharose commences even during the damping, whereas reducing sugars remain nearly constant during the same period. (3) The variation

of reducing power represents the activity of respiration.—Chemical process for the purification of water, by MM. F. Bordes and Ch. Girard. Calcium permanganate is employed to oxidise the organic matters, and the excess of this salt is removed by treatment with lower oxides of manganese. The treatment recommended removes organic matter also by physically precipitating it from the water, which, after treatment, contains no micro-organisms, and very little calcium carbonate.—On the wheat produced on a saliferous soil in Algeria, by MM. Berthault and Crochetelle.—On the abnormal fronds of ferns, by M. Ernest Olivier.—Origin and division of granular nuclei in large sarcomatous cells, by MM. O. Van der Stricht and P. Walton.—A note, by M. Delaurier, concerning an easy method of obtaining a perfect vacuum without mechanism, deals with the production of a vacuum by absorption, as with oxygen and iron at a red heat.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Birds, Beasts, and Fishes of the Norfolk Broadland: P. H. Emerson (Nutt).—Balistique des Nouvelles Poudres: E. Vallier (Paris).—Gauthier-Villars.—La Théorie des Procédés Photographiques: A. de la Baume Pluvinet (Paris, Gauthier-Villars).—La Distillation: E. Sorel (Paris, Gauthier-Villars).—Dissections Illustrated: C. G. Bridie, Part 4 (Whittaker).—Methodisches Lehrbuch der Elementar Mathematik: Dr. G. Holzmüller, Dritter Teil (Leipzig, Teubner).—A Primer of Evolution: E. Clodd (Longmans).—Geometrical Conics: F. S. Macaulay (Cambridge University Press).—Standard Dictionary, Vol. 2 (Funk and Wagnalls).—Outlines of Zoology: J. A. Thomson, 2nd edition (Pentland).—The Book of the Dead. The Papyrus of Ani in the British Museum: Dr. E. A. W. Budge (British Museum).

PAMPHLETS. Report of the Meteorological Council to the Royal Society for the Year ending March 31, 1894 (Eyre and Spottiswoode).—Stonyhurst College Observatory. Results of Meteorological and Magnetic Observations, 1894. Rev. W. Sidgreaves (Clitheroe).—18th Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois (Springfield, Ill.).

SERIALS.—Cassell's Magazine, April (Cassell).—Chambers's Journal, April (Chambers).—Century Magazine, April (Unwin).—Natural Science, April (Rait).—Zeitschrift für Wissenschaftliche Zoologie, lix. Band, 1 Heft (Leipzig, Engelmann).—Gazzetta Chimica Italiana, 1895, Fasc. 2 (Roma).—Humanitarian, April (Hutchinson).—Contemporary Review, April (Isbister).—National Review, April (Arnold).—Fortnightly Review, April (Chapman).—Bulletin de la Académie Royale des Sciences, &c., de Belgique, tome 29, No. 2 (Bruxelles).—Geographical Journal, April (Stanford).—Journal of the Royal Agricultural Society of England (third series), Vol. vi. Part 1 (Murray).

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